THE

MINERAL RESOURCES

— OF —

SOUTH-EASTERN OHIO

— BY —

JENKIN W. JONES

GALLIPOLIS, OHIO

NOVEMBER, 1897

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THE GALLIPOLIS TRIBUNE PRINT
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Introduction.

This report is intended to be a conservative statement of the real conditions in a practically undeveloped section of great mineral wealth. It is based on much practical engineering field work, on personal observation and investigation covering a period of seven years, and on the judgment and experience of reliable and successful men engaged in related lines of business.

The object is the presentation of the possibilities of the field in the process of its development. Comparisons are made to show the probabilities of the future in the light afforded by the partial development of the past. Wherever estimates are given, they will be found lower than the many that have been made along same lines, the writer preferring rather to be too low than too high, so that due allowance may be m[illegible] unseen which often prevents the full realization of reasonable expectation[illegible] measurements [illegible] personally conducted and all minerals unfit for the market are so classified.

The accompanying map and sections present to the eye the location of the field, the favorable lines for railroad construction, the geological order of the mineral deposits, the numerous sections where practical tests have been made, and finally a fair conception of the general industrial conditions and possibilities.

Nature has been very lavish in her gifts to this section of Ohio and capital can nowhere find a better place for safe and profitable investment.

JENKIN W. JONES.

Gallipolis, Ohio, November, 1897.

The Mineral Resources of South-eastern Ohio.

The most valuable mineral district in south-eastern Ohio includes the south-eastern part of Scioto County, the eastern half of Jackson County, the western half of Gallia County, and nearly all of Lawrence County.

The principal minerals of the district having commercial value are sandstones, limestones, shales, clays, iron ore, and coal. Their existence in particular localities is not a matter of chance, but each and all have their places in the established order of geological history, and he who is familiar with this history knows as well where to look for stores of mineral wealth as the student who easily turns to the pages of his favorite author for the gems of literature. The district heretofore named is a part of one continuous field, extending on the west side of the Appalachian Range from western New York to central Alabama, and the minerals are generally deposited in layers. To understand the geology of any section of the country, therefore, it is necessary to become acquainted with the vertical order of the strata and the degree and direction of their inclination to the horizon.

The following section combining a geological survey and the record of a test well for oil, near Adamsville, in the south-eastern corner of Raccoon Township, Gallia County, is a fair representation of the geological arrangement on a vertical line of the strata in the district under consideration.

STRATA.	THICKNESS.	DEPTH.
Upper Cambridge limestone....	2 feet	feet
Red clay	7 "	9 "
Hard sandstone	2 "	11 "
Shale	21 "	32 "
Lower Cambridge.....	3 "	35 "
Slate.....	15 "	50 "
Red shale	5 "	55 "
Slate and shales	26 "	81 "
Sandstone	28 "	109 "
Slate.....	15 "	124 "
Waterloo coal (No. 7).....	2 "	126 "
Clay	2 "	128 "
Slate.....	18 "	146 "
Red shale	4 "	150 "
Surface (well head).....	24 "	174 "
Sand and gravel	2 "	176 "
Sandstone	42 "	218 "
Slate, coal No. 6[a] and clay	5 "	223 "
Sandstone	26 "	249 "
Shale	13 "	262 "
Hocking Valley coal (No. 6)...	7 "	269 "
Clay and slate.....	67 "	336 "
Coarse sandstone	7 "	343 "
Ferriferous limestone	7 "	350 "
Coarse sandstone	25 "	375 "
Sandy shale.....	23 "	398 "
Sandstone	42 "	440 "
Slate.....	39 "	479 "
Sandy shales	74 "	553 "
Coarse sandstone (gas)	42 "	595 "
Black slate	55 "	650 "
Mercer limestone and slate.....	70 "	720 "
Sandstone	16 "	736 "
Jackson shaft coal (No. 1).....	1 "	737 "

STRATA.	THICKNESS.	DEPTH.
Conglomerate Series.		
[a]Coarse sandstone	31 feet	768 feet
[b]Salt sand (salt-water)	475 "	1243 "
Sub-carboniferous limestone	wanting.	
Logan Group.		
[a]Shale	31 "	1274 "
[b]Conglomerate "Big Indian" Cap.....	3 "	
"Break" in "Big Indian".....	8 "	
"Big Indian" (very strong salt-water)	30 "	
Total thickness "Big Indian"..	41 "	1356 "
Cuyahoga Shales.		
[a]Sandstone	15 "	1371 "
[b]Shale	52 "	1423 "
[c]Fine dark sandstone.....	6 "	1429 "
[d]Coarse sandstone	17 "	1446 "
[e]Gray sandstone.....	30 "	1476 "
[f]Shale.....	25 "	1501 "
Berea Series.		
Berea shale (black)	20 "	1521 "
Berea cap (fine showing for oil)		
Berea grit (small amount of salt-water)	15 "	1536 "
Bedford Shale.		
[a]Blue shale	8 "	1544 "
[b]Red shale.....	60 "	1604 "
Cleveland Shale.		
[a]Blue shale (stopped drilling)	4 "	1608 "

Incidentally it may be said that when the drillers first tapped the Berea they thought that they had "struck oil." The sand for the first three feet seemed to be full of oil, but deeper drilling led only to disappointment in the accumulation of salt-water. A test in Section 29, Huntington Township, showed a similar geological structure. In this well, however, the Cleveland shale was drilled into 595 feet without change.

To comprehend the general geological structure in relation to the inclination of the strata to the horizon it is necessary to locate some well known stratum extending under all the territory in question. The Berea grit is the best stratum for that purpose. It is readily distinguished by its peculiar formation and by the underlying Bedford shale, which always tells its own story by the red products of the drill.

The Berea is 90 feet above sea level at Jackson, 50 feet above at Sciotoville, 460 feet below at Ironton, 750 below at Adamsville, and 1170 feet below sea level on the Beale farm in Mason County, W. Va., just across the Ohio River from Gallipolis. By triangulation, or the usual method of determining the amount and direction of the dip in strata, it will be found that the Berea dips to the south-east about 35 feet to the mile. This is speaking in general terms, of course; for the best that can be expected in geological structure is uniformity in the general arrangement and irregularity in local formations. The Ohio valley is approximately the geological trough of Ohio, Kentucky, West Virginia, and Pennsylvania. The coal seams that appear on the surface in Ohio and north-eastern Kentucky dip under drainage and again come to the surface by a reverse dip on the west side of the Allegheny mountains.

The Hocking Valley, Wellston and Waterloo coal fields have their places deep under all that part of the Ohio River which is north of Huntington, W. Va., and they come to the surface again in the great coal fields of West Virginia and Pennsylvania.

So much for the general structure, of which we must have a proper conception to understand fairly well the importance of local fields.

Sandstones and Limestones.

The sandstones are valuable for the production of sand and for building purposes. The shipping of sand is conducted at present from only two points, Jackson and Vinton, and that in limited quantities. There is no reason, however, why it should not be made a profitable business when properly conducted and favorable means of transportation afforded. The entire section is supplied with the fine grained and coarse sandstones, suitable for a variety of commercial uses.

There is an unlimited amount of the finest quality of building stone at Gallipolis and the new state institution at that place, the Ohio Hospital for Epileptics, is now building its fine structures exclusively of the native sandstone. When completed, there will will be 37 buildings, covering 60 acres of land, and costing over a million dollars. When first taken out of the quarry, the stone is soft, but it hardens by exposure and makes a beautiful stone, excellent in quality, and fine in appearance.

The limestones of the section having any value are the Cambridge and the Ferriferous. There are two seams of the Cambridge, the Upper and the Lower, about 30 to 40 feet apart, the later about 235 feet above the No. 6 coal.

The lower is flinty in some localities and in its best condition is not so good as the upper. The seam being so thin and generally lying under the heavy cover of the hills will never have any commercial value. The Upper Cambridge (about 3 feet thick) has a local value for the production of lime and the construction of macadamized roads. This is a comparatively pure limestone and the deposits in Walnut and Mason townships will become valuable at once when railroad transportation is provided. In one acre there are 4840 square yards. In the townships named, the seam is about 3 feet thick, which would make 4840 cubic yards per acre. One cubic yard of limestone weighs one and one-half tons, therefore one acre of the Cambridge limestone would produce 7260 tons, which at the usual royalty of 5 cents would come to $363 per acre.

The Ferriferous limestone lies about 70 feet below the No. 6 coal or about 300 feet below the Cambridge. The surface exposures of this seam extend in a north-east direction along the line of the encircled letters on the map. It falls below drainage on the west side of Symmes, Greenfield, Raccoon and Huntington townships, making the exposed area approximately six miles wide. The thickness of the seam is generally from 6 to 9 feet. It contains by analysis not less than 90 per cent. of carbonate of lime, and has been used for furnace flux throughout the entire period of iron production in the Hanging Rock district. Its continued use in the manufacture of iron is assured. The extent of its use can be approximately estimated on the basis of 1.30 tons of limestone for every ton of iron produced. It has also been successfully used in the production of lime,

though in a limited way. Being covered with a valuable iron ore and underlaid with a good coal seam, the mining of the three minerals at once can be economically conducted, and there are good reasons for the belief that an important industry can be established in this section in the production of lime.

Ores and the Production of Iron.

There are many varieties of iron ore in the district extending from the conglomerate on the west to the Cambridge limestone on the east, but only those will be considered which are proved to be the most valuable. Relative to the ores which appear highest in the geological order, I have the privilege of quoting from a recent report of J. H. Holliday, Esq., of Knoxville, Tenn., and Thomas Hamilton, of Ironton, Ohio, whose personal investigation of the Waterloo field was thorough and whose character and experience are such as to make their observations worthy of the highest consideration. They say : "But little iron ore has been mined in this section, although large deposits of 48 and 50 per cent. ores have recently been developed. These ores can be traced through all the hills in the Waterloo basin. 'Red Kidney' ore is found high in the hills. A seam, locally known as the 'Blagg ore,' a few feet under the limestone (7^b) coal, shows a thickness of from eighteen inches to three feet. It is comparatively soft and easily mined, and will work raw in blast furnaces. This ore was mined thirty years ago for the Mt. Vernon Furnace Co., and used extensively in the manufacture of pig iron. Owing to the long distance and unimproved roads over which it was necessary to haul it with ox teams, and the fact that the furnace company had an abundance of other ore near at hand, its use was abandoned. Several veins of block ore, rich in metallic iron, crop out in the hills and are thrown along the turnpikes and public road. The ores of the Waterloo field will find a ready and profitable market among the furnaces of the Hanging Rock iron region when railroad transportation is provided."

The Boggs or flag ore is the lowest in the geological order and is therefore found on the western [illegible] of the field. It was extensively mined in the neighborhood of South Webster many years ago. The [illegible] ore of the lower strata which is now extensively used is found near Jackson, where the supply is said to be inexhaustible. The seam has an average thickness of about 7 feet over a large area. The Star Furnace at Jackson has a daily capacity of 35 tons, using 75 per cent. native coal and 25 per cent. coke for fuel, mixing mill cinder and the flag ore in equal parts. The product is a high silicon iron, extensively used as a softener in foundries. Less than a hundred feet above the Boggs ore, may be found three layers of block ores, which are rich in quality but poor in quantity.

About 100 feet above the upper block ore is the well known and most important limestone ore. As stated, heretofore, this ore is immediately overlying the ferriferous limestone and is almost coextensive with that stratum over its exposed area. It has been the chief source of supply for over 50 furnaces in the Hanging Rock region for as many years, and still only the margin of the seam has been taken along the out-crops on the hillsides. It has an average thickness of about one foot and will produce about 3000 tons of ore to the acre. A careful estimate of the limestone ore above drainage in the territory included in the map will make an area of 6x40 miles, or 240 square miles. Allowing for the area cut by the valleys and removed in benching, there still remains not less than 200 square miles of this superior ore. 128,000 acres will produce 384,000,000 tons of ore. Analysis and experience show that the limestone ore contains about 40 per cent. metallic iron when raw and 55 per cent when calcined. On this basis the limestone ore in this section would be sufficient to produce not less than 150,000,000 tons of pig iron, which would make a continuous train twice encompassing the world. For future use the ore must be mined by drifting, but in these days of enterprise and ingenuity the economical mining of the ore will not be a difficult problem for the progressive engineer. If it were not for the superior qualities of the iron produced, the decay of this industry might be predicted on account of the heavier deposits in the south and north-west, but with the development of the coking coal in this field that disadvantage will be overcome and the growth of the iron industry will be assured. The most gratifying success of the Jackson and Wellston furnaces during the recent period of financial depression is the best commentary that can be made relative to the possibilities of iron production in this section. Mr. Joseph Clutts, General Manager of the Wellston furnace, has made such a success of the business that his company continually carries orders six months in advance of their production. The following statement

from the pen of a furnace man of large experience, taken from the "Industrial Edition" of the Ironton Register, is a clear and accurate account of the superiority of the native ores : "The superiority of our ores consists in their neutral qualities. Thus, all pig metal is classed as red-short, cold-short or neutral. Red-short iron is strong when cold, brittle when hot. A cold-short iron is strong when hot, weak when cold. Red-shortness is a term used to describe an iron that cannot be worked by rolling or forging at, or above, a dull red heat without cracking or fracturing. If forged above such a heat, it crumbles beneath the hammer. Among the elements, which, in small quantities, produce red-shortness are sulphur, copper, antimony, silver, etc. Those that produce cold-shortness are phosphorus, silicon, etc. Cold-short irons are the cheap irons. They are worthless for many purposes. They are mostly made in the South and are used for cheap castings and very common bar iron. The red-short irons are mostly from Lake Superior ores. They are strong but shrink in casting. A red-short iron will bend, but will not readily weld. A cold-short iron will weld, but will not bend cold. Neither class will make chain iron, in consequence. Now, the product from our native ore is a neutral pig iron. It will both bend and weld, does not shrink in casting and is very strong. You can make anything from it requiring first class quality of iron. The Hanging Rock native pig metal brings the highest prices in the market—it is the best made in America, if not in the world." The United States government used pig iron from this ore very extensively in the manufacture of heavy ordnance during the late war with most satisfactory results. By mixing the native ores with lake ores, the Hanging Rock district can make any grade of iron to suit the demands of the market and many of the furnaces are now doing this. If they can already successfully compete with the South using West Virginia and Pennsylvania coke and lake ores, they will control the iron situation when saving a dollar per ton on native coke. There is no location in America more favorable for the establishment of a prosperous business in the production of iron. The ore, the flux, and the fuel are [illegible]nd for the production of the highest grade of iron, used in the manufacture of car wheels, machine cast[illegible]d all iron products requiring strength and chilling qualities. This is practically a saving of freight rates on raw material, an advan[illegible] not within the reach of the great iron cities of the country. If the necessities of the market call for a cheaper iron, the freight rates on raw material will be increased only by the rate on lake ore, which can be brought to the furnaces on coal cars returning from the north-west. The Hanging Rock region enjoys another advantage over the South in its nearness to the great iron markets, by which it can save about $2.00 per ton freight rates on pig iron. A still further advantage can be gained in the manufacture of finished iron and steel products in the Hanging Rock region. There are already many such plants in the cities of Portsmouth, Ironton, Ashland, Huntington, Gallipolis, Jackson, and Wellston, but the development in this line of business is only a feeble beginning as compared with its possibilities.

Clays and Shales.

Clays and shales are so closely related in composition that it is a difficult matter to determine the line separating the two. Stratified clays may be properly called shales. True clays do not present a laminated structure. The clay bed itself is not divided into layers. Clays and shales crumble on exposure to the atmosphere. Slates and shales are similar in composition and in appearance, but the former do not crumble on exposure, having been hardened by heat and pressure.

Prof. Edward Orton, Ohio State Geologist, classifies the varieties of clays and their respective uses as follows :

		Uses.
High Grade Clays.	1. Kaolin.	Manufacture of fine ware.
	2. China clays.	" " "
	3. Porcelain clay.	" " "
	4. Fire clay (hard).	Refractory materials.
	5. Fire clay (plastic).	" "
	6. Potters' clay.	Earthenware, etc.

		Uses.
Low Grade Clays.	1. Argillaceous shale.	Paving block, etc.
	2. Ferruginous shale.	Pressed brick, etc.
	3. Silicious clays.	Paving block, sewer pipe, etc.
	4. Tile clays.	Roofing tile, draining tile.
	5. Brick clays.	Pressed brick, ornamental brick.
	6. Calcareous shale.	Common brick, etc.

There is perhaps none of the first of these divisions of the high grade class in south-eastern Ohio. The best deposits of hard fire clay are found in parts of the townships of Porter, Harrison, Vernon, and Bloom of Scioto County, and in the townships of Madison and Jefferson in Jackson County. The hard clay of Scioto County occupies the place of the subcarboniferous limestone. In some places in Bloom township, on the old Scioto Furnace lands, the seam reaches a thickness of 11 feet, and rarely falls below 4 feet. The large plants at South Webster, Portsmouth and Sciotoville derive their supply of raw material from this seam. Its quality and its commercial importance may be seen from the following statement of the eminent scientist heretofore quoted.

"This clay is one of the two or three strictly first class clays of the state. It has been worked largely at Sciotoville and Portsmouth, and is accordingly commonly designated in Ohio as the Sciotoville clay. Other outcrops of it occur near Logan, Hocking County, and here it is called the Logan clay. It has been used in manufactures here also, to quite an extent. Whenever found, its great value is at once recognized. It becomes a basis of manufacture of fire clay products in the strictest use of this word. Furnace linings and other similar uses demanding refractory quality and high grade absorb the entire product of this seam. A single analysis exhibits the general characteristics of the Sciotoville clay. (*Lord.*)

Silica	50.95
Alumina	39.49
Alkalies	.30
Magnesia	.28
Water	9.18

These figures show a deposit approaching absolute purity, and attest the very great value of the clay. Unfortunately the deposits of this seam in Ohio are few in number." That, it is true, is unfortunate for the state at large, but fortunate for the company which controls the limited territory.

The fire clay at Oak Hill, Jackson County, is a mixture of the hard and plastic varieties and lies over the Kittanning coal. It is extensively used in the manufacture of several varieties of fire brick, by two large and prosperous companies.

It is the opinion of Mr. George Edmonds, General Manager of the South Webster Fire Brick Company, who has had many years' successful experience in the business, that nearly the whole of the southern half of Bloom and the north-western part of Vernon townships is underlaid with this very valuable clay. There are only three sections in the United States that can furnish fire clay equal in quality to the Sciotoville seam. These are Mt. Savage, Maryland; West Moreland County, Pennsylvania; and St. Louis, Missouri. A very fine building brick is manufactured by the South Webster and other companies in the Sciotoville district and shipped to all parts of the United States. For instance, the former company is now filling an order of 400,000 brick, 224 different paterns, for the St. Paul Catholic Church, Chicago. They are continually increasing the capacity of the plant and have never seen the time when they could fill all orders. This is only the general history of the industry.

Farther to the east in the mineral district of south-eastern Ohio, we find the plastic clays in inexhaustible quantities and thoroughly approved for their superior qualities. This clay is found under all the coal seams in the district, but we find it in its best development just above the Ferriferous limestone in Lawrence County and just over the No. 6 coal in Huntington township. In the latter place, the seam is about 5 feet thick. The overlying stratum is a very hard fine-grained sandstone which will resist pressure to such a degree as to make an excellent roof for mining. The coal seam underlying the clay is separated into two benches by a shale parting 20 to 30 inches thick In this one mine, we find 5 feet of superior coal, excellent shale, and an abundance of plastic clay,—all the raw material necessary for the successful manufacture of paving brick. It has been demonstrated by practical tests that the shale paving blocks are superior to the clay products, and that a mixture of clay and shale produces better results than either alone. The plastic clay above the limestone ore is on the same geological level as the clays which have been the foundation of the great potteries at East Liverpool, the largest in the world. Means, Kyle & Co., of Hanging Rock, have furnished this clay to the Rookwood Pottery at Cincinnati for twenty years. It is of such excellent quality that it

supplied the body to this work of fine art, known and admired the world over. It is extensively shipped to Cincinnati and Louisville for the manufacture of sewer-pipe. Mixed with shale, it is largely used in the manufacture of paving brick at Ironton.

The following is the opinion of Edward Orton, jr., the most scientific authority on clay industries in the state: "The products of this horizon are used on a great scale in the finer pottery manufacture for saggers, also in part for the manufacture of Rockingham and yellow ware ; and lower still in the scale of value, for stoneware. These clays are a main dependence of great sewer-pipe factories, and also are sometimes used in making fire-brick of ordinary quality. An enormous amount is now being turned to account in the manufacture of paving brick. By reason of the uses and adaptations above named the Kittanning clay seems certain to hold for all time to come the first place in our clay horizons."

There is an abundance of shale for all purposes. Throughout a large part of the district, there is a red shale which is designed to become very valuable as a mixture with clays to produce a building brick of various shades. The seam is about 4 feet thick with a good roof and bottom. The clays and shales of south-eastern Ohio are suitable for the manufacture of the greatest variety and the highest class of products. Every city in Ohio that has largely engaged in this line of business has become wealthy and prosperous. In proof of this statement, I cite the experience of Zanesville, Akron, and East Liverpool. What has been done can be done, and will be done.

Coal and Coke.

The coal seams of the state are known by local names, by numbers, and by the nomenclature of the Pennsylvania reports ; as Hocking Valley, No. 6, and Middle Kittanning, all names common to one seam. In this report the numbers will be chiefly used. The figures in parentheses refer to the encircled figures on the map. The lowest coal in the geological order is the No. 1, and is locally known as the Jackson shaft coal.

The Mahoning coal of Ohio and perhaps the New River coal of West Virginia occupy the same geological level as the Jackson shaft coal. The city of Jackson is located in the best development of the field in south-eastern Ohio. The seam is somewhat irregular, but quite a large area will average a thickness of 4 feet, (Section 1). For domestic use, the coal cannot successfully compete in the markets with some of the other coals of the district, but so far it leads them all in its superior qualities for furnace use.

The No. 2 or Wellston coal field covers a large area in the north-eastern part of Jackson County. On the west side of the field the mines are above drainage, but on the high lands and on the east side the coal is reached by shafts of varying depths. The seam is from 26 to 50 inches in thickness, the average being about 36 inches, (Sections 2, 3, and 4). It is comparatively free from foreign materials, consequently the production of the mines in its various forms is always in condition for the market. In quality, the coal is open burning, and is adapted for furnace use as it comes from the mine. Being low in ash and high in carbon, its most important use is in domestic consumption. It burns clean in the grates and makes a strong, but not lasting heat. It has never failed in competition with any other coal of Ohio, Pennsylvania, or West Virginia. It is not generally known that there is a valuable extension of the field to the east, in the Little Raccoon Valley, but a recent test for oil on Keton's Run, Huntington Township, disclosed a seam of usual thickness, (Section 7). The area covered by the Wellston field within defined limits is estimated not to exceed 25 square miles; yet it has made Jackson the first county of the state in the amount of coal produced and Wellston the second general shipping point in Ohio. The official shipments of coal by the four railroads during the month of October amounted to 13,050 cars of 22 tons each, or a continuous train over 90 miles long. There are many mines in which the coal never reaches a thickness of 30 inches, but they have paid their owners handsome dividends on the investment and many times as much as $300 per acre have been paid for the coal privileges.

The thorough investigation of the Little Raccoon Valley in Gallia county is a matter worthy of attention. The coal can be reached at a depth of about 200 feet.

The Limestone or No. 4 coal is found in abundance in eastern Jackson, north-western Lawrence, eastern Scioto, and western Gallia. It does not seem to hold its own under drainage. The core drill showed a thickness of two feet of poor coal in Huntington township, Gallia County. In the Adamsville oil well, there was

no trace of this seam, (Section 31). It lies immediately below the Ferriferous limestone, hence the name.

The seam is usually separated by bands of slate or clay, making mining more expensive, though not necessarily more difficult. The coal is adapted for domestic use and is especially valuable for steam coal, for all boilers having a strong draught. The coal has not been able to compete with some of the other Ohio coals; but in future years when the superior coal fields of the district have been exhausted, the railroads projected for the development of the former will have an almost inexhaustible supply of the Limestone coal to rely upon.

The Newcastle or No. 5 coal has been extensively mined in Lawrence County for many years. It has been the chief reliance of the many manufacturing industries of Ironton. The seam is about 40 inches in thickness and comparatively free from impurities. The principal mines are located at Newcastle and at Vesuvius Station, (Sections 30 and 29, respectively). It seems to have a valuable extension to the north and east. It is now mined for shipping, domestic use, and steam production at Oak Hill, (Section 14), and it has been recently opened for domestic use in the north-east corner of Madison township, where it shows a good volume and fair qualities on the outcrop, (Section 35). In Section 13, Perry Township, Gallia County, the writer drilled a test hole with a core drill through the No. 6 and the No 5. The latter showed a thickness of 36 inches without a trace of any foreign matter in the seam. It is 55 feet below the No. 6, covered with 19 feet of black slate, which is good evidence that the coal is persistent over a large area. The coal presents a remarkable fine appearance and makes that section of very great importance on account of the possibility of establishing a coking industry in that valley. It is the equivalent of the Leetonia, Ohio, coking coal, which is by far the purest and the strongest in the state. It is said on good authority to be equal to the best foreign coking coal, and next to Connellsville. The Newcastle coal near Ironton makes a good strong coke, but the coal in the upper Symmes Valley is far superior in quality. It is in better volume than the Leetonia coal, and there is no question about its meeting the requirements of a coking coal. With one unimportant exception, the western coals do not coke. The short hauls to the Hanging Rock furnaces and the reduced freight rates to the west and north-west would find a ready sale for the full production of the seam. In a report to the United States Government on the "Bituminous Coal Field of Ohio, Pennsylvania, and West Virginia," Prof. I. C. White, of the Morgantown University, who ranks among the first geologists of the country, in discussing characteristic horizons, makes the following statement in regard to the Lower Kittanning or No. 5, locally known as the "Newcastle:" "It is probably the most persistent bed in the Appalachian field, and has a workable thickness over a larger area than any other. In Pennsylvania it furnishes from 3 to 4 feet of valuable fuel over large areas in every county where its outcrop is due. It has also been successfully coked in the Tucker County, West Virginia, field, since it is nearly always a good coking coal everywhere. On the Great Kanawha River, above Charleston, this is one of the principal coal beds, and has long been known as the Campbell's Creek vein. In Ohio the Lower Kittanning coal is almost as persistent as in Pennsylvania, rarely being absent entirely from the section, and generally having a thickness of 3 feet, with a maximum of 5."

In south-eastern Ohio the Middle Kittanning or No. 6 coal seam extends through the central and eastern part of the territory included in the map. The best known developments are in the Little Raccoon and Symmes Creek Valleys in Gallia and Lawrence. There are many thousand acres in the Little Raccoon Valley where the seam is persistent throughout the field. It ranges in thickness from 3 feet in a solid bed to 5 feet of marketable coal in the composite seams. In the north-west corner of Huntington, (Section 5), the seam shows a fine volume of excellent quality. On Tiger Creek, Bloomfield Township, it is mined for local use and maintains its usual characteristics, (Section 6). On Little Raccoon, (Section 8), the writer put down a well 38 feet deep to the bottom of the No. 6 coal. The following section shows the composite character of the seam, which is characteristic of the Hocking Valley coal:

	FEET	IN.
Very hard sandstone	11	
Plastic fire clay	2	6
Horn coal		3
Marketable coal	1	10

	FEET	IN.
Slate parting		3
Inferior coal		6
Clay parting		5
Coal excellent quality	3	2

It is interesting to compare the similarity in the structure of this seam and the Newburg shaft coal, Preston County, West Virginia, of which the following is a section:

	FEET.	IN.
Coal marketable	1	
Slate		3
Coal slaty	2	
Clay	2	
Coal good	2	

The difference is only in the thickness of the respective layers, the former making the better showing.

The coal has been opened near Vinton to test its qualities in the market with other coals. The Gallipolis and Point Pleasant Railway Company made a test of the coal recently. For steam purposes it showed 12 per cent. better results than any other Ohio coal which the company had used and 8 per cent. better results than the best grade of Kanawha coal. The other tests made confirm the foregoing report. The coal is also thoroughly approved for domestic use. It is low in ash and high in carbon. It produces a strong heat without being "flashy." The seam shows about 3½ feet of good coal near Centreville, (Section 36), in a solid bed. When the old Washington Furnace was in operation, (Section 32), the coal was extensively mined and successfully used raw in the smelting of iron.

In the valley of Symmes Creek, in the townships of Perry, (Section 17), Greenfield, (Section 15), and Walnut, (Section 18), this coal seam is again found in excellent condition. The coal is about 52 inches with a slate parting 4 inches thick about 20 inches below the black state roof. It is definitely known that the coal bed maintains this structure for many square miles of territory. The coal occupies its place throughout the Symmes Creek Valley as far as the Ohio River at the old Sheridan coal works near Ashland, (Section 28). This field has an important extension into Kentucky, and everywhere maintains its good qualities. The test wells for oil at Adamsville, Mills Station, Point Pleasant, and Gallipolis found this bed in good condition at the depths of 112, 585, 500 and 517 feet respectively, (Sections 9, 10, 12, and 13). The thickness of the bed in each well was over 7 feet. The heavy drill could not determine the composite character of the seam, but the tests seem to point to an unusually large and important undeveloped coal field in the extreme south-eastern part of Ohio.

It is sometimes stated that this coal seam is too thin to be profitably mined, but the experience of Wellston does not justify this conclusion. It is quality and not quantity that makes a successful coal business. The chemical analysis of the No. 6 coal in the Symmes Creek Valley shows the highest per cent. of fixed carbon and the lowest in ash of any coal in the state, making it, therefore, the most desirable for steam and domestic use.

Prof. White's report on the characteristics of this coal in Pennsylvania and West Virginia is produced as further evidence on this point. "It is the most important seam in Butler, Lawrence, and Beaver Counties, the coal being quite pure and highly esteemed for gas, steam and domestic purposes, though it seldom exceeds 4 feet in thickness, and is often much less. This is the famous "Clinton," "Rock Point," and "Hog Hollow" coal along the Beaver River. It is always divided by one or more thin slate partings, one of which is usually near the bottom. Southward from Pennsylvania, in Maryland and northern West Virginia, this coal is sometimes thick enough to mine, though seldom exceeding 2½ to 3 feet. In the Great Kanawha field, this bed, although only 3 to 4 feet thick, is very pure and valuable, being known there under the names of "Cedar Grove," "Trimble," "Arno," and others."

This seam alone makes an extensive coal field in south-eastern Ohio, superior in quality, sufficient in quantity, relatively near the great coal markets, and hard enough to stand shipping and stocking.

The Waterloo or No. 7 coal has its best development in the townships of Walnut, Symmes, Aid, and Lawrence, with the probability of a valuable extension under drainage to the east. That is a question to be settled by the explorations of the core drill within this territory. The seam ranges from 4 to 7 feet in thickness, is usually complex in structure, and is occasionally cut out in narrow channels by the overlying sandstone. In all places, however, where there is a good slate roof the seam is persistent, and in all it covers a very large area in the Waterloo field. Webster's bank, (Section 19), shows nearly five feet of marketable coal with two partings aggregating 8 inches in thickness. Pearce's bank, (Section 20), shows about 4 feet of excellent coal. The Thomas Cooper bank, (Section 21), near Waterloo produces about 5 feet of good coal. Near the head of Aaron's Creek, (Section 25), on the Griffiths farm, the seam shows a thickness of 4 feet with a two-inch parting. At this point it has a good roof and shows up well for a good shipping mine.

Near the head of Sharps Creek, the seam is 7 feet thick with only 2 inches of parting near the middle, and it all seems to be of superior quality. In Section 25 of Aid Township, on the east side of Symmes Creek, the seam will produce about 4 feet of marketable coal. In Lawrence Township on the Willis farm, (Section 32), the coal is stripped, and shows the following structure: Top coal, 24 inches; bone coal, 8 inches; clay parting, 4 inches; bottom coal, 30 inches. These measurements show the extent of the field above drainage and they indicate unmistakably the further extension in good condition to the east and south. In quality, the coal is open burning, higher in ash than the No. 6, but very low in sulphur. Experts think it can be used raw in the smelting of iron. This coal seam is high enough to be attacked with mining machines, extensive enough to be operated on a large scale, and good enough to enter the best markets.

The Waterloo coal field is one of the most valuable undeveloped fields in the state. When prospectors and promoters shall have greater interests in the development of the Waterloo coal field than in the working of mines already opened in established fields, then the extent and importance of the new field will be made manifest.

The No. 7^{b} coal, (Section 22), under the Cambridge limestone, is of mineable thickness and is locally used for fuel and steam production.

The Pomeroy or No. 8 coal covers a limited area in the north-eastern part of Gallia County, and has been mined at Carlton for many years. There is a probability that the "Jeffers" coal of Clay, Harrison, Ohio, (Section 23), and Guyan Townships belongs to this horizon. It covers a large area in sufficient volume to be easily mined. It is comparatively free from impurities and is considered an excellent steam coal.

The following table of analyses from the state and mine reports is presented for the sake of comparison:

	1	2	3	4	5	6	7	8	9	10
Moisture	6.98	5.20	5.73	8.57	8.57	4.75	1.39	5.76	....	3.60
Volatile matter	36.65	28.80	36.76	36.40	32.70	39.15	36.18	35.52	36.83	37.86
Fixed carbon	50.14	64.20	51.99	51.39	55.43	50.35	57.36	55 77	61.27	56.14
Ash	6.23	1.80	5.52	3.64	3.30	5.75	5.07	2.95	1.90	2.40
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Sulphur	.57	.79	1.42	.61	.47	.77	.79	2.95	....	.82

1. Thos. Cooper's Mine, Walnut Township, No. 7 coal.
2. Evans' Mine, Greenfield Township, No. 6. coal.
3. Poston Mine, Nelsonville, No. 6 coal.
4. Wellston Coal and Iron Co., Wellston, No. 2 coal.
5. Jackson Shaft, Jackson, No. 1 coal.
6. Pomeroy Coal Company, Pomeroy, No. 8 coal.
7. Youghiogheny, Penn.
8. McGugin's Mine, Olive Furnace, No. 4 coal.
9. Cedar Grove, W. Va., No. 6 coal.
10. Leetonia, Ohio, No. 5 coal.

In the foregoing discussion of the coal seams, the merits of each were separately presented. Now, it becomes necessary to unite them for a general view of the field. As far as tests have been made, there are four very important locations in south-eastern Ohio. They are the hard clay fields in Scioto County, the Waterloo coal field, the Perry Township coal field in Gallia County, and the Huntington Township field. The Perry Township section is valuable on account of the superior qualities of the No. 6 and No. 5. coals, and the Huntington Township section on account of the No. 6 and No. 2 or Wellston coal. In forming plans for the

best development of the south-eastern Ohio minerals, those four important locations should be kept in mind constantly. It was impossible to designate on the map the probable boundaries of any coal seam; for over a large part of the field, there are two or three seams underlying the same section. A large area around each of the three important coal centers named will average 8 feet in the combined measurement of the two seams. Many times, there are several seams in a section, and there is very little territory that does not contain one. A coal seam can be safely estimated to produce 100 tons per acre for each inch in thickness. A four-foot seam, therefore, would produce 4800 tons. Operators aim to clear 25 cents per ton, even on large contracts. The profit per acre, then, to the operator in mining a four-foot seam would be $1200. With the improved business conditions in this country, there is a very great demand for coal, and coal men are seeking new territory.

Recently, Hon. Andrew Roy, Mining Engineer of Glen Roy, Jackson County, Ohio, who served 9 years as State Mine Inspector, wrote to the Jackson Standard-Journal as follows: "The people of Jackson County should begin to cast about for other coal fields to draw upon. A road from Wellston or Jackson to Ironton, via the Symmes Creek Valley, would pass through the lower coal measures all the way, cutting every seam of the series, from the Jackson shaft coal, to the Wellston seam—from No. 1 to No. 7. There are facts in our possession to warrant the statement that a road from Wellston or Jackson, via the Symmes Creek Valley, would traverse a coal region of greater promise, both as to quality, thickness, and extent of seam, than any known unoccupied coal field of the lower coal measures of Ohio."

Development Proposition.

Whoever will take the pains to verify what has been said in the preceding pages will find in this section of south-eastern Ohio a rich field of undeveloped wealth. Here is a combination of the most favorable industrial conditions that can be found anywhere in the United States. The development along one line of industry will add to the importance of the others. To secure the best results, there ought to be sufficient capital to control the clay, iron, coal, and railroad interests in the undeveloped field for one company. Usually in undeveloped sections, the first requirement is the construction of a long line of railroad; but in this case, the building of a main line 45 miles long, with two lateral branches, as indicated on map, will form a belt line passing through all the important parts of the field and making connections with seven of the best railroads in Ohio. The main line from Gallipolis to Sciotoville, connecting with the C. P. & V., would make Gallipolis and Huntington equally distant from Cincinnati. The main line and branches would give three direct connections to Cincinnati, three to Columbus, and three to Toledo, and from those cities to all points in the west and north-west. Under such conditions, the company would never be embarrassed on account of freight rates to any part of the country. The last Congress of the United States adopted the continuous plan for the improvement of the Ohio River by movable locks and dams. This will make the Ohio River navigable the entire year, excepting the possible interferrence by ice. The coal could be shipped on barges, making a cargo of a half million bushels of coal for each tow-boat, to all points in the south. Ironton is 100 miles nearer the southern markets than the nearest Kanawha mines and 330 miles nearer than the Pittsburg mines. Many of the Pennsylvania mines are farther from the river than the Waterloo field. By rail, the coal and coke from south-eastern Ohio would be 170 miles nearer the western and north-western markets than the nearest mines of West Virginia, shipping via the C. & O. and the N. & W. The only requirement for success is the organization of a strong company. That is the secret of the successful career of the West Virginia companies. They are strong enough to command favorable rates on the railroads. A strong company can secure better rates for shorter hauls and the quality of our coal will make a market anywhere and everywhere. The main line would "cross the country" geographically and geologically, shortening distances by important cross connections and passing over all the mineral formations possessing commercial value.

The writer concludes this report by expressing the hope that this presentation of the mineral resources of south-eastern Ohio will awaken a spirit of inquiry and investigation, and is confident that his conclusions will be fully confirmed. The accompanying supplementary report will present details not deemed advisable to include in this general statement.